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ABSTRACT

Financing at the leading 100 research universities in the United States was studied during 1975-79, along with the programmatic and resource characteristics of the institutions, using data collected by the National Science Foundation and by the Higher Education General Information Survey program. The results clearly indicate that the leading research universities receive significant shares of their funds from federal grants and contracts (mostly for research). However, without additional information about specific institutional policies that are tied to these Federal funds (e.g., in supporting tenured versus contract staff, core versus ancillary services, etc.), it is not possible to assess the true nature of dependency on federal funds. In addition, the finding that high rates of federal contract support for research appear to be accompanied by substantial amounts of funding from other, nonfederal sources, further tempers the implications of dependency on federal funds. However, the findings suggest the importance of regularly monitoring the impact of funding on research activities. Since 1960, federal research and development funds have increasingly been directed toward academically-based researchers, at the expense of industry-based research. An important linkage between research and graduate education, particularly at the doctoral level, is indicated. This association is most evident in the doctoral fields of engineering, physical sciences, and life sciences. Issues related to the study methodology and data-related considerations are also addressed, and a bibliography is appended. (SW)

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FINANCING AT THE LEADING 100 RESEARCH UNIVERSITIES

A Study of Financial Dependency, Concentration, and Related Institutional Characteristics

Marilyn McCoy

Jack Krakower

David Makowski

Paper Presented at the

1981 AIR Forum

Minneapolis, Minnesota

May 1981

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THE ASSOCIATION FOR INSTITUTIONAL RESEARCH

This paper was presented at the Twenty-First Annual Forum of the Association for Institutional Research held at the Leamington Hotel in Minneapolis, Minnesota, May 17-20, 1981. This paper was reviewed by the AIR Forum Publications Committee and was judged to be of high quality and of interest to others concerned with the research of higher education. It has therefore been selected to be included in the ERIC Collection of Forum Papers.

Mary Corcoran
University of Minnesota
(Editor, AIR Forum Publications)

ABSTRACT

FINANCING AT THE LEADING 100 RESEARCH UNIVERSITIES

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This paper presents results of a National Science Foundation sponsored study to examine the financing of the leading 100 research universities. The study examines the changing dependence of these institutions on the federal government for overall financial support, the shifts in the concentration of federal funding to and within higher education, and the various programmatic and resource characteristics of these leading research institutions. The study covers five fiscal periods, 1975 through 1979.

Introduction

Anxiety about finances is a widespread condition in higher education, prompted by continued high inflation rates, taxpayer revolts, the potential of declining enrollments, and the forecast of recession. This general concern about financial conditions assumes a particularized character when it is focused on the research that is conducted in academic settings in this country. Because the leading 100 research universities perform approximately 85 percent of the sponsored research carried out by higher education institutions, the financial status of these institutions has direct implications for the maintenance of research capacity in the U.S. In addition, although research activity has, to a large extent, been a federally financed enterprise, the separability of research activities from the overall mission and funding of universities is not a practical reality. Thus a singular analysis of research is by necessity supplanted by an examination of overall university operations and funding.

This report is an abbreviated summary of the major findings from a study of financing at the leading 100 research universities in the U.S. between 1975 and 1979.[1] This 18-month study, conducted by NCHEMS with funding from the National Science Foundation, was based on the parallel use of data from two sources: data collected by the National Science Foundation in its Universities and Nonprofit Institutions Studies Group in the division of Science Resources Studies and data collected by the National Center for Education Statistics in its Higher Education General Information Surveys (HEGIS) program. The study was assisted by the participation of an evaluation panel composed of representatives from 12 institutions from the leading 100 research universities. Representatives were selected from a mix of institutions that differed in control (public and independent), in extent of research activity, in special

[1]The full report, Financing at the Leading Research Universities by McCoy, Krakower and Makowski is available from NCHEMS.

program arrangements (separate medical campus versus medical school integrated within a campus, landgrant institutions, operation of separate research institutes), and in reporting practices (campus and system offices). This panel provided regular and significant input throughout the duration of this research about the design, data, and results of all analysis. The institutions and individual representatives on this panel included:

Cornell University - W. Donald Cooke, Vice President for Research
Florida State University - Ilona Turrisi, Director of Budget and Analysis
Massachusetts Institute of Technology - Robert M. Dankese, Associate Budget Director
Michigan State University - Robert Lockhart, Director of Budgets
Ohio State University - William E. Vandament, Vice President for Finance and Planning
Oregon State University - Robert W. MacVicar, President
University of California-Irvine - Leon Schwartz, Vice Chancellor for Administration and Business Services
University of Colorado-Boulder - Richard Harpel, Assistant Vice Chancellor for Academic Affairs
University of Denver - Robert Amme, Chairman, Department of Physics
University of Hawaii-Manoa - Durward Long, Chancellor
University of Virginia - Dennis W. Barnes, Associate Provost for Research
University of Washington - Robert K. Thompson, Assistant Vice President for Planning and Budget

Although the National Science Foundation regularly monitors R&D activities at the leading research institutions in science and engineering fields, an examination of research in the context of overall financial conditions at the leading institutions has not occurred. Such a review of financing is considered essential because (1) research is so completely integrated into the mission, finances, and operations of these institutions that a separate assessment of research eclipses numerous important interrelationships, (2) changes in non-federal funding and in activities beyond research can have important repercussions for the research roles of these institutions, and (3) these institutions represent an identifiable and ongoing resource of major importance to the nation's research effort, now and in the future,

and therefore the continued well-being of these institutions per se is an important national concern.

It is clear that for the leading research institutions, definitions of institutional identity and mission are intimately associated with research activities. The continued establishment of a viable financial base therefore implies careful and repeated attention to overall financing, not just the financing of research. To begin to address some of the financial and programmatic relationships between research and other institutional activities, this study examines:

- o Dependency - the extent and change in the financial reliance of these institutions on federal and other funds for total educational and general revenues as well as total R&D support.

- o Concentration - the extent to which higher education's share of the total federal R&D pie has changed (a) relative to other major research providers (i.e., industry, the federal government, other nonprofits, and the Federally Funded Research and Development Centers [FFRDC's]) and (b) among different categories of higher education institutions (i.e., leading research, other graduate, and all other institutions).

- o Characteristics of Research Universities - the distinctive features of leading research universities in comparison to other institutions in terms of size, graduate focus, emphasis on doctoral studies, resource levels, science orientation of the curriculum, and emphasis on particular disciplines. Relationships between these characteristics and institutional dependence and funding levels are explored.

Related Studies

Although the empirical review of research funding in the context of total institution finances is believed to be a first, many other studies have examined topics that are under review in this report.[2] The National Science Foundation itself is the most important and prolific source in monitoring research funding, its distribution, and many of its impacts. Regular publication by NSF of Science Indicators, Federal Support to Universities, Colleges, and Selected Nonprofit Institutions and National Patterns of Science and Technology Resources are among their most visible and important efforts from the perspective of this study.

A major premise underlying the work in this report is that there are a small number of academic institutions with a decided research mission that conduct the bulk of academically sponsored R&D. NSF's own statistics buttress this position by describing high degrees of concentration in the delivery of R&D. From 1971 to 1979 the leading 100 research universities have consistently received over 80 percent of all federal R&D obligations going to colleges and universities.[3] Both Smith and Karlesky[4] and Nozicka[5] further emphasize the concentration of federal R&D funding within higher education. Based on empirical analysis, Nozicka concluded that the concentration of federal support for academic research is based on a highly skewed distribution of research capability among the institutions identified by Ladd-Lipsett as most distinguished.

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[2] This same conclusion is also drawn by Ellyson and Krueger who characterized the bulk of research in this area as qualitative versus quantitative.

[3] Federal Support to Universities, Colleges, and Selected Nonprofit Institutions, FY1979, NSF, Washington, D.C.: Government Printing Office, chart 10.

[4] Bruce L. R. Smith and Joseph J. Karlesky. The State of Academic Science: Volume II - Background Papers. New Rochelle, N.Y.: Change Magazine Press, 1978.

[5] George J. Nozicka. Federally Funded Research and Development at Universities and Colleges: A Distributional Analysis. Final Report, Vol. I and II. Washington, D.C.: Moshman Associates, February 1979.

Nozicka also found that this funding pattern was related to the submission of proportionately more proposals by these same institutions.[6] Nozicka found that these patterns were relatively stable during the period under study (1973-1977). Dispersion of such funding was observed in a slight "trickle down" fashion only in those years when federal R&D funding increased significantly. (Note: The findings in this study do not corraborate this "trickle down" effect.) As a result, Nozicka sees small likelihood of substantial change in the distribution of federal R&D funding away from the major university performers. Certainly the conclusions of Smith and Karlesky reinforce this prediction. In their study they perceived a very rapid deterioration occurring at the weaker departments and institutions over the coming years, which would reduce the ability of these institutions to effectively compete for federal funds.

A second premise underlying the current study is that because research is inextricably interwoven into the fabric of operations at the leading research institutions, a review of the financing of research necessarily requires an examination of the institution as a unit—both financially and programmatically. The integral role of research for these institutions is a long recognized condition. Charles R. Kidd's analysis in American Universities and Federal Research (1963) provides an important statement about the complexity of the relationships between federal funding and university based research. Certainly it is this basic interlinkage that undergirds the need for this study, which shifts analysis of research from a singular focus on research activity to the context of overall university operations and funding. The analysis of dependency and its implications is thus the major novel contribution of this study.

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[6]Nozicka, George. Federally Funded Research and Development at Universities and Colleges, A Distributional Analysis. Washington, D.C.: Moshman Associates, 1978, p. 153

A major focus of this research study is an examination of the implications of research activity, particularly those that can be related to dependency on federal funding. A slightly different perspective has been taken by Ellyson and Krueger in their article, "Predicting Federal Research Funding at Colleges and Universities,"[7] in which they examined characteristics of colleges and universities which they felt were tied to the receipt of federal R&D support. Their results indicated that the number of doctoral degrees awarded and the expenditure of the institution's own funds for research were highly correlated to federal research funding. In further differentiating their findings, Ellyson and Krueger showed that number of doctorates was more important at independent institutions whereas commitment of institutional funds for research was more important at public institutions. This finding bears out a more decided emphasis at private universities on graduate instruction as shown in a forthcoming report by McCoy and Halstead, Higher Education Financing in the Fifty States, FY79. That study found that graduate enrollments at independent research institutions represented between 35 and 40 percent of total FTE enrollment.[8] At public research institutions this emphasis was significantly lower, in the 15 to 20 percent range.

Technical Notes

There are a number of important cautions that the reader should be aware of in reviewing this report. As will become clear in the next section, the time period under study represents a period of relatively positive economic conditions that distinguishes it from the time period that preceded it as well as the one that has immediately followed. In addition, the period under study, 1975-1979, is very short given the questions under study. Finally, problems associated with using data from

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[7] Edgar J. Ellyson and Jack P. Krueger. "Predicting Federal Research Funding at Colleges and Universities." Research in Higher Education, 13,2(1980):131-36.

[8] Marilyn McCoy and D. [illegible] Halstead. Higher Education Financing in the Fifty States, FY[illegible]. National Institute of Education. Washington, D.C.: Government Printing Office, forthcoming.

two different sources necessitated a series of analytical adjustments that may affect results. For each of these reasons, the reader should recognize that the findings reported here are tentative and more definitive conclusions are dependent on the extension of this analysis to a longer time series at a later time.

To guide the reader in interpreting the material which follows, some analytical and definitional clarification is offered here.

(a) Institutions Included in this Study - To resolve differences in the reporting units in the NSF and NCES surveys, a number of institutions were dropped from the study population (the leading 100 research universities). This shift reduced the size of the study population from 100 to 71 institutions. Institutions which opened, closed, or merged or failed to report data needed in the study were also excluded. Analysis of the characteristics of the excluded institutions suggested that the remaining institutions were an unbiased representation of the full population.

(b) Composition of Research - Only separately budgeted, sponsored research is included in this study. The exclusion of departmental research causes academic research to be underestimated in this study, but because there are no national data on the extent of such departmental research, the omission of this research was necessary.

In addition, NSF and NCES use different procedures to collect and report information about research. Most importantly, (1) NSF includes only R&D in science and engineering fields, whereas NCES includes research in all fields; (2) NSF reports R&D expenditures by source, whereas NCES reports revenues by sources (federal, state, etc.) and expenditures by use (instruction, research, etc.); (3) NSF reported R&D expenditures do not

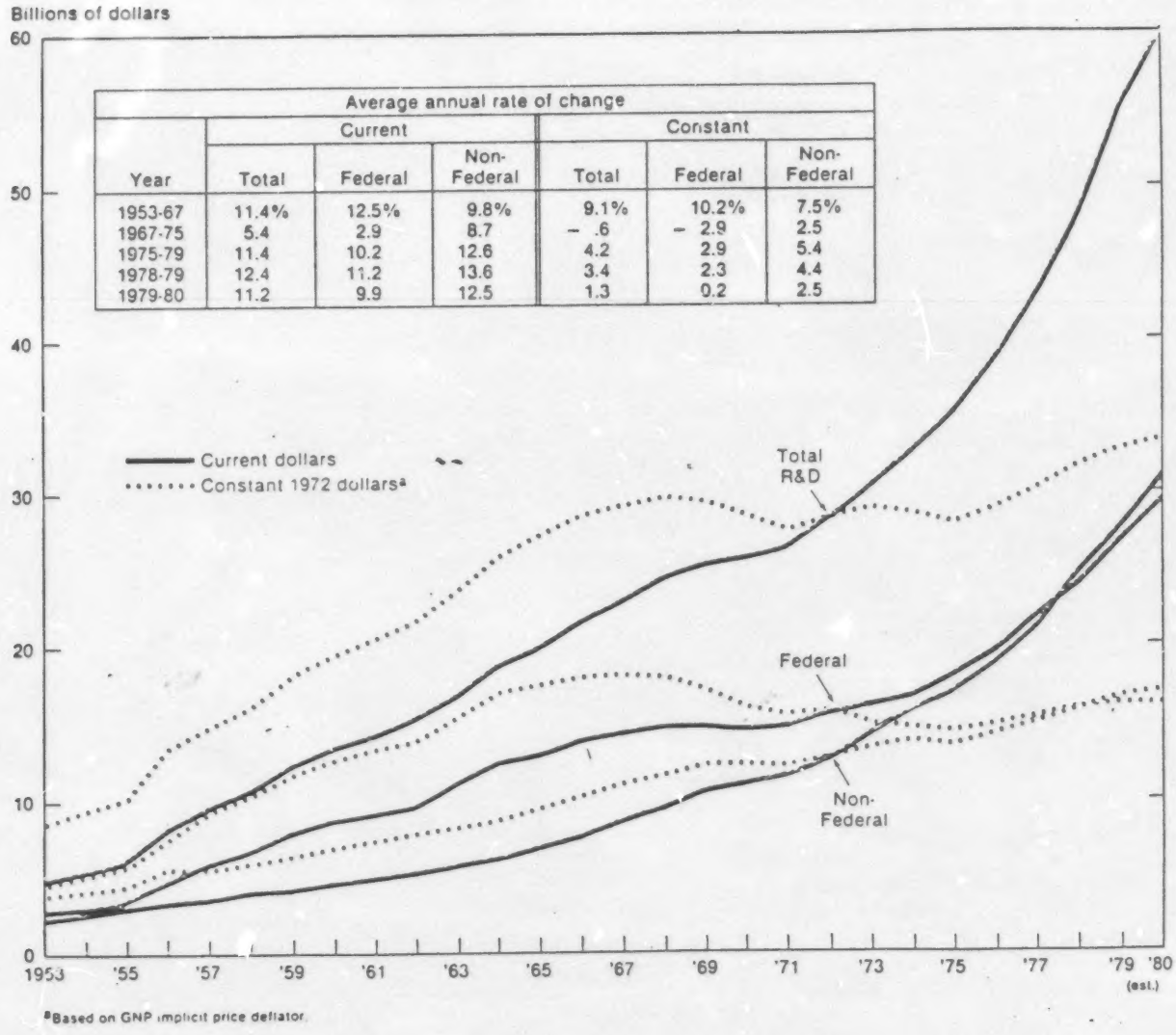
include funds for purposes other than R&D, whereas NCES includes other activities besides research (such as training grants) in its federal grants and contracts revenues category; and (4) NSF reports indirect cost reimbursement within each R&D expenditure category. NCES likewise includes indirect cost reimbursement in its report of revenues but distributes such funds across the appropriate expenditure categories such as institutional support, academic support, and operation and plant maintenance, thereby separating such funds from the "research" expenditure category.

National R&D Trends

As illustrated in figure 1, the period 1975-1979 which is the focus of this study was characterized by current and constant dollar growth for research. R&D grew by 11.4 percent in current dollar terms and 4.2 percent in constant dollars during this period. By contrast, the period that preceded it (1967-1975), saw a -.6 percent drop in constant dollar R&D activity in the U.S., as a result of a -2.9 percent decline in federal R&D support.

Figure 1

National R&D Funding

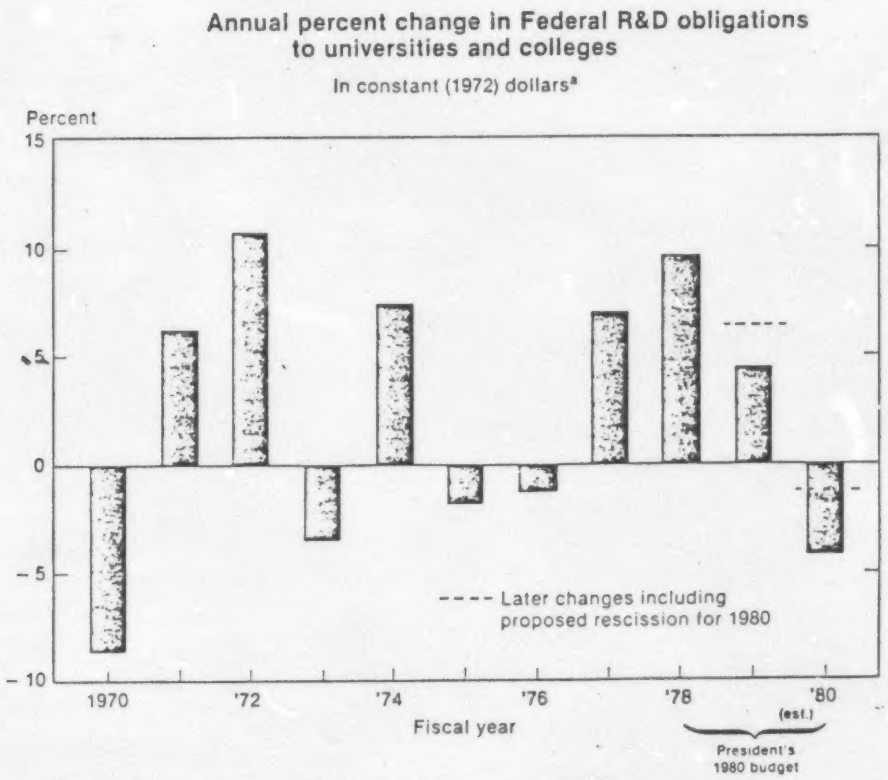


Average annual rate of change						
	Current			Constant		
Year	Total	Federal	Non-Federal	Total	Federal	Non-Federal
1953-67	11.4%	12.5%	9.8%	9.1%	10.2%	7.5%
1967-75	5.4	2.9	8.7	- .6	- 2.9	2.5
1975-79	11.4	10.2	12.6	4.2	2.9	5.4
1978-79	12.4	11.2	13.6	3.4	2.3	4.4
1979-80	11.2	9.9	12.5	1.3	0.2	2.5

Source: National Science Foundation, National Patterns of Science and Technology Resources 1980, NSF, Washington, D.C.: GPO, chart 14, p. 13.

While the data in figure 1 suggest that in 1979-80 (based on estimated data) R&D will increase in real terms, such growth is not generally anticipated for academic institutions. Both NSF estimates (see figure 2) and the sentiment expressed by members of the project's Evaluation Panel suggest a decline in real R&D past 1979. Many individual Evaluation Panel members further generalized this anticipated decline for R&D to other areas of university funding, particularly that from state government sources.

Figure 2



[a]Based on the GNP implicit price deflator with an estimate for fiscal year 1980.

Source: Federal Funds for Research and Development, FY78, 79, 80, vol. XXIII, National Science Foundation, Washington, D.C.: GPO, chart 7, p. 8; table 4, p. 8; and chart 8, r. 9.

Funding at the Leading Research Universities

An examination of funding trends at the leading research universities between 1975 and 1979 further reinforces the depiction just provided of improved finances during that period. As shown in table 1, total E&G revenues increased by 42 percent in current dollars from $146.7 million per institution in 1975 to $207.8 million in 1979. In dollars adjusted for inflation, this increase still represents an 8 percent increase in funds at these institutions. Although federal grants and contracts grew at a somewhat lesser rate (34 percent), real dollar gains in funding were also experienced from this source (3 percent in constant dollars). The average amount received per institution in federal grants and contracts climbed from $28.3 million in 1975 to $38.1 million in 1979. This period is clearly characterized by funding gains for the leading research institutions in total and in federal grants and contracts. Even after adjusting for a 3 percent increase in enrollment, the leading research institutions improved their financial base during this period.

Table 1

Changes in Federal Grants and Total Revenues Per Institution
1975-1979
NCES Data

	N	1975	1976	1977	1978	1979
Total Revenues (in thousands of current dollars)						
Top 100	71	$146,748	$159,034	$177,513	$186,828	$207,836
Public	42	$144,221	$154,843	$174,162	$180,054	$199,431
Private	29	$150,408	$165,103	$182,365	$196,638	$220,010
Federal Grants and Contracts (in thousands of current dollars)						
Top 100	71	$ 28,347	$ 30,508	$ 32,252	$ 34,160	$ 38,114
Public	42	$ 24,177	$ 26,265	$ 27,202	$ 28,413	$ 31,918
Private	29	$ 34,725	$ 37,275	$ 39,926	$ 42,857	$ 47,087

Index of Current Dollars

	N	1975	1976	1977	1978	1979
Total E&G Revenue						
Top 100	71	100	109	117	128	142
Public	42	100	108	116	129	141
Private	29	100	109	119	128	142
Federal Grants and Contracts						
Top 100	71	100	108	114	121	134
Public	42	100	109	113	118	132
Private	29	100	107	115	123	136

Index of Constant Dollars

	N	1975	1976	1977	1978	1979
Total E&G Revenue						
Top 100	71	100	102	103	106	108
Public	42	100	101	102	106	108
Private	29	100	102	104	106	109
Federal Grants and Contracts						
Top 100	71	100	101	100	100	103
Public	42	100	102	99	97	101
Private	29	100	101	101	102	104

Dependency on Federal Sources for E&G Revenues

The federal government has assumed the major role in supporting research and development in this country. 1980 estimates indicate that federal sources provide approximately one-half of all funds for R&D. For higher education institutions, the next logical issue is assessing the extent to which federal funds dominate in their total funding and in their R&D funding.

Dependency on federal funds has both financial and programmatic implications for the leading research institutions. Given the Reagan administration's proposals to slow the rates or increase in federal spending, there is a developing potential that institutions which receive large shares of federal funds may face a slackening

economic future. While such cuts would be related to a variety of specific conditions, such as programmatic areas of research, high dependency does signal a condition of general vulnerability.

Not only do the leading research universities depend on federal funds for their financial well-being, but they have buttressed important components of their programmatic activity on this support. For the set of institutions being examined in this study, activities in research and graduate education are intimately associated with their self-definition. The mission of these institutions has been clearly demarcated from those of the remaining segments of higher education in terms of these two sets of activities. As will be indicated in later sections of this report, the leading research institutions do, on average, 20 times as much research as other graduate institutions and they enroll five to six times as many graduate students in their instructional program (based on analysis of NCES data). To the extent that such programmatic emphases are federally supported, then the character and mission of these schools may be dependent in a special way on federal funds. In addition, given the focus of federal funding on specific disciplines, added programmatic dependence can be hypothesized.

Although it is clear that federal funding of research is extremely important both programmatically and financially to the leading research universities, institutional dependency on federal support of research is also a major issue of federal interest. The knowledge and expertise that has been developed at leading research universities by federal and other funding represents a key resource of continuing importance in this nation's research effort. As providers of research and the major training ground for future researchers (both within and outside of higher education), these universities have evolved to a position of national eminence and expertise that cannot

be readily replicated if impaired. It is thus with an eye to the future capacities of these institutions that the question of dependency is examined.

"Dependency" is operationally defined (using NCES data) as the share of total institutional funds (educational and general) that derive from federal grants and contracts and even more restrictively (using NSF data) as the share of total R&D expenditures for science and engineering that is provided by the federal government. Although such definitions are tractable, their simplicity belies the fundamental concept inherent in such relationships. Such statistics do in fact convey a numerical indication or resource share furnished by a particular source. Such statistics, however, do not illuminate the associated institutional policies that more clearly give definition to the relationship. Since institutions differ in the allocation of these outside funds (e.g., support of contract versus tenured staff, ancillary versus core services, etc.), they also differ in the degrees of real dependence on a particular funding source. Unfortunately, existing data are not sufficiently detailed to allow such a thorough exploration of true "dependency."

(a) Extent of Dependency - Analysis of dependency in this study indicated that the leading research universities receive major shares of their funds from federal grants and contracts. Private universities in this category received 34.4 percent of their E&C funds from federal grants and contracts in 1979 (source: analysis of NCES data). Public universities received lesser though still important shares, 21 percent of total E&G revenues from federal grants and contracts. As shown in table 2, federal grants and contracts represent the single largest source for leading private universities and the second most important source for the public universities, after state and local appropriations.

Table 2

Percentage Shares of E&G Revenues by Source
Leading 100 Institutions
(Source: NCES, 1979)

Leading Public Institutions		Leading Private Institutions	
State & Local Appropriations	53.7%	Federal Grants & Contracts	34.4%
Federal Grants & Contracts	21.0%	Tuition	32.9%
Tuition	12.2%	Gifts	14.3%
Gifts	5.0%	Endowment Income	9.5%
State & Local Grants and Contracts	2.6%	Other E&G	4.7%
Federal Appropriations	2.5%	State & Local Grants and Contracts	2.6%
Other E&G	2.0%	State & Local Appropriations	1.4%
Endowment Income	1.1%	Federal Appropriations	.2%

(b) Variations in Dependency Among Research Universities - The leading 100 research universities vary substantially in the extent of their reliance on federal grants and contracts. In 1979, the most dependent institution, California Institute of Technology, received 62 percent of all revenues from federal grants and contracts, followed by Stanford University at 52.7 percent and Massachusetts Institute of Technology at 51.2 percent. The least dependent institution of this group, the University of Arkansas, received only 3.4 percent of its funds from this source. Table 3 provides a listing of the dependency ratios for 71 of the leading 100 research universities, the institutions included in this study.

Table 3

Institutional Dependency Ratios
Percent of Federal Grants and Contracts to Total E&G Revenues 1979
Leading Research Universities
(NCES Data)

CAL INST OF TECHNOLOGY	62.0	BROWN UNIVERSITY	24.1
STANFORD UNIVERSITY	52.7	U OF CAL-LOS ANGELES	23.8
MASS INST OF TECHNOLOGY	51.2	U ALABAMA IN BIRMINGHAM	23.7
U OF CAL-SAN DIEGO	48.3	NEW YORK UNIVERSITY	23.7
ROCKEFELLER UNIVERSITY	42.5	PRINCETON UNIVERSITY	22.8
JOHNS HOPKINS UNIVERSITY	41.7	U OF CAL-BERKELEY	22.3
WASHINGTON UNIVERSITY	41.1	UTAH STATE UNIVERSITY	22.2
UNIVERSITY OF CHICAGO	40.2	UNIVERSITY OF ARIZONA	21.8
U OF CAL-SAN FRANCISCO	39.5	U OF TEXAS AT AUSTIN	21.4
UNIVERSITY OF DAYTON	39.1	UNIVERSITY OF IOWA	21.1
UNIVERSITY OF WASHINGTON	37.5	U OF CAL-IRVINE	21.0
YESHIVA UNIVERSITY	37.1	U OF ILL URBANA CAMPUS	19.8
UNIVERSITY OF ROCHESTER	36.6	MICHIGAN STATE UNIVERSITY	17.4
YALE UNIVERSITY	36.5	GEORGETOWN UNIVERSITY	17.3
CASE WESTERN RESERVE U	34.6	UNIVERSITY OF FLORIDA	17.1
DUKE UNIVERSITY	33.5	U OF MD COLLEGE PARK CAM	15.1
U OF PENNSYLVANIA	33.0	FLORIDA STATE UNIVERSITY	15.0
U TEX HLTH SCI CTR DALLAS	32.6	WASHINGTON ST UNIVERSITY	15.0
UNIVERSITY OF MIAMI	32.4	U OF CAL-DAVIS	15.0
VANDERBILT UNIVERSITY	32.4	U OF MASS AMHERST CAMPUS	14.7
U OF SOUTHERN CALIFORNIA	32.0	VIRGINIA COMMONWEALTH U	14.2
COLUMBIA U MAIN DIVISION	31.4	UNIVERSITY OF GEORGIA	13.3
UNIVERSITY OF UTAH	30.6	WAYNE STATE UNIVERSITY	12.2
U OF WISCONSIN MADISON	30.0	U OF NEBRASKA-LINCOLN	12.2
UNIVERSITY OF DENVER	28.6	U OF CAL-RIVERSIDE	11.8
COLORADO STATE UNIVERSITY	27.7	U OF MISSOURI-COLUMBIA	11.8
HARVARD UNIVERSITY	27.1	IOWA STATE U SCI & TECHN	11.7
CARNEGIE-MELLON U	26.9	MISSISSIPPI ST UNIVERSITY	11.5
NORTHWESTERN UNIVERSITY	26.5	VA POLY INST AND STATE U	11.1
EMORY UNIVERSITY	26.3	KANSAS ST U AGR & APP SCI	10.6
GEORGE WASH UNIVERSITY	26.2	UNIVERSITY OF DELAWARE	9.9
OREGON STATE UNIVERSITY	25.8	WEST VIRGINIA UNIVERSITY	8.7
BOSTON UNIVERSITY	25.6	NC STATE U RALEIGH	8.3
U OF NC AT CHAPEL HILL	25.2	CLEMSON UNIVERSITY	5.1
U OF RHODE ISLAND	25.1	U OF ARKANSAS MAIN CAMPUS	3.4
U OF HAWAII AT MANOA	24.9		

(c) Comparative Dependency Rates - A comparison of the dependency ratios of the leading 100 institutions with "other graduate" and "all other" institutions gives further emphasis to the special relationship of the leading research institutions with the federal government. Whereas the leading 100 universities showed an average reliance on federal grants and contracts for

20-35 percent of their funds, "other graduate" institutions receive only about 10 percent or their funds and "all other" institutions about 6-7 percent of their funds from this source. These comparisons further demonstrate the substantial reliance of leading research institutions on federal support through grants and contracts.

(d) Changes in Dependency - The leading 100 research universities became slightly less dependent on federal sources (grants and contracts) for their total educational and general revenues over the study period, fiscal years 1975-79. The public institutions in this category began this period receiving 22.4 percent of total revenues from federal grants and contracts; by 1979 federal sources represented 21 percent of their revenues. For the private institutions in this category, the decline was slightly larger from 36.1 percent of total E&G to 34.4 percent. (Source: analysis of NCES data) Table 4 provides figures on these changes.

Table 4

Changes in Dependency on Federal Grants and Contracts
1975-1979
NCES Data

	N	1975	1976	1977	1978	1979
Federal Grants and Contracts						
Top 100	71	27.5%	27.2%	26.7%	25.8%	26.1%
Public	42	22.4%	22.5%	21.7%	20.5%	21.0%
Private	29	36.1%	35.5%	35.0%	34.7%	34.4%

Although the time period studied is too brief to provide definitive indications about changing dependency, the above finding contradicts one of the original hypotheses of this study--that the leading research universities were becoming more dependent on federal funding. Instead, we find that constant dollar increases in federal grants and contracts have

been outpaced by constant dollar gains in other revenue sources, causing relative dependency on federal funding to lessen to some degree.

An analysis of changes in dependency at individual institutions indicated that almost half (48 percent) of the institutions in this study showed decreasing dependency on federal grants and contracts as a major revenue source. Another 31 percent were basically stable in their degree of dependency.[9] Twenty-one percent of the institutions in this study increased their level of dependence on federal grants and contracts.

(e) Dependency at Landgrant and Institutions with Medical Programs - To assess whether specialized types of campuses exhibited different dependency patterns, the study conducted similar analyses for landgrant and non-landgrant institutions and for institutions with an integrated medical[10] facility, a separate medical campus, or no medical programs. The study indicated that dependency did not appear to be strongly related to landgrant status. Instead, changes for these institutions appeared to mirror changes for the leading public research institutions and showed similarly slight declines in dependency. (Source: analysis of NCES data) Institutions with an integrated medical facility or a separate medical campus showed declining reliance on the federal government for grant and contract support. For institutions without medical programs, there was a stable or somewhat increasing level of dependence on federal funds. These findings were most evident for the "other graduate" institutions and less marked for the leading research institutions. It can be hypothesized that these data

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[9]A modified definition of dependency is used here. If an individual institution's ratio changed less than 1.5 percentage points (plus or minus), the institution was considered to be stable in its reliance on federal funds. This differs from a strict definition of simple positives and negatives.

[10]Medical is defined to include medicine, dentistry, osteopathic medicine and veterinary medicine.

provide an early indication of decreasing federal support for medical education through capitation grants. Since university associated hospital operations were not analyzed in this study, the influence of medicare and clinical practice funds are not evident.

(f) Changes in Research Expenditures - Growth in research expenditures at leading public universities exceeded rates of increase in federal grants and contracts as well as total E&G revenues. Research expenditures at these public institutions increased by 45 percent, in part fueled by the infusion of the institution's own funds into these activities and in part by a 32 percent growth in current dollar federal grants and contracts. This increase in research is further notable in light of the fact that it exceeded the rate of increase in E&G revenues of 38 percent. At the leading private institutions, research expenditures increased by a slightly lesser rate than the gain in federal grants and contracts (32 percent for research and 36 percent for federal grants and contracts). E&G revenues at these private universities increased by 46 percent overall.

In dollar terms, the leading public research institutions experienced on average a $7.7 million increase in federal grants and contracts and in turn spent $11.2 million more for research. At leading private institutions, a $12.4 million increase in federal grants and contracts was accompanied by a $9.2 million gain in research expenditures.

Although currently, private research institutions spend a larger share of their funds on research activities, the gap between public and private research institutions declined over this period. In 1975, the relative figures for proportion of budget devoted to research for public and independent research universities was 23.4 percent and 28.4 percent,

respectively. By 1979, these figures had moved closer, at 23.7 percent and 26.3 percent, respectively.

Dependency on Federal Sources for R&D Funds

The foregoing analysis looked at federal grants and contract revenues and research expenditures in terms of total E&G funding, using NCES data. The remaining discussion in this section looks at a more narrow topic--R&D expenditures for science and engineering and the relative role of federal funds in supporting these expenditures, using NSF data.

(a) Extent of R&D Dependency - The leading research universities rely very heavily on the federal government for support of R&D. In 1979, the federal government provided 61.3 percent of total R&D funds to public institutions and 78.6 percent of such funds for the independents. Without question, the federal government carries the predominant role of support for R&D at these institutions.

(b) Variations in R&D Dependency Among Research Universities - On an individual institutional basis, high rates of dependency on federal funds is evident. The most dependent institutions receive almost 90 percent of their R&D funds from the federal government. The least dependent institution of this group received 12.7 percent of R&D support from federal funds, but only 4 of the 71 institutions studied received less than 30 percent of their R&D funds from the federal government. In fact, 56 of the 71 institutions studied received more than half of their R&D funding from the federal government. Table 5 provides a listing of these leading research institutions in terms of their dependency on the federal government for R&D expenditures.

Table 5

R&D Dependency
Percent Federal R&D Expenditures to Total R&D Expenditures 1975-79
All Top 100 Institutions
(Source: NSF)

STANFORD UNIVERSITY	90.0	CASE WESTERN RESERVE U	71.2
BOSTON UNIVERSITY	89.9	U OF CAL-BERKELEY	71.0
U OF CAL-SAN DIEGO	89.4	COLORADO STATE UNIVERSITY	69.2
EMORY UNIVERSITY	88.5	U OF TEXAS AT AUSTIN	65.5
CAL INST OF TECHNOLOGY	88.1	UNIVERSITY OF ROCHESTER	65.0
UNIVERSITY OF DAYTON	87.2	CARNEGIE-MELLON U	64.5
DUKE UNIVERSITY	86.0	U OF WISCONSIN MADISON	63.9
GEORGE WASH UNIVERSITY	86.0	U OF MD COLLEGE PARK CAM	63.5
JOHNS HOPKINS UNIVERSITY	85.6	U OF HAWAII AT MANOA	63.0
MASS INST OF TECHNOLOGY	85.4	UTAH STATE UNIVERSITY	62.5
BROWN UNIVERSITY	84.7	WAYNE STATE UNIVERSITY	61.8
UNIVERSITY OF UTAH	84.2	U OF MASS AMHERST CAMPUS	61.0
UNIVERSITY OF WASHINGTON	84.1	U OF ILL URBANA CAMPUS	58.8
U OF CAL-SAN FRANCISCO	83.9	GEORGETOWN UNIVERSITY	58.3
YALE UNIVERSITY	83.5	WEST VIRGINIA UNIVERSITY	57.2
U OF CAL-IRVINE	83.1	UNIVERSITY OF DELAWARE	56.5
U ALABAMA IN BIRMINGHAM	82.7	UNIVERSITY OF ARIZONA	54.1
U OF RHODE ISLAND	81.8	OREGON STATE UNIVERSITY	53.9
YESHIVA UNIVERSITY	81.2	UNIVERSITY OF FLORIDA	53.3
UNIVERSITY OF IOWA	81.2	U OF CAL-DAVIS	50.1
VIRGINIA COMMONWEALTH U	80.9	ROCKEFELLER UNIVERSITY	48.5
COLUMBIA U MAIN DIVISION	80.9	VA POLY INST AND STATE U	46.8
U OF NC AT CHAPEL HILL	80.5	MICHIGAN STATE UNIVERSITY	44.4
VANDERBILT UNIVERSITY	79.6	FLORIDA STATE UNIVERSITY	43.5
U OF CAL-LOS ANGELES	79.6	WASHINGTON ST UNIVERSITY	41.7
U TEX HLTH SCI CTR DALLAS	79.0	U OF MISSOURI-COLUMBIA	38.7
WASHINGTON UNIVERSITY	79.0	U OF CAL-RIVERSIDE	34.6
UNIVERSITY OF CHICAGO	77.4	IOWA STATE U SCI & TECHN	33.2
NORTHWESTERN UNIVERSITY	76.5	NC STATE U RALEIGH	33.0
HARVARD UNIVERSITY	75.7	UNIVERSITY OF GEORGIA	30.8
UNIVERSITY OF DENVER	75.6	KANSAS ST U AGR & APP SCI	30.4
NEW YORK UNIVERSITY	75.0	CLEMSON UNIVERSITY	29.1
U OF SOUTHERN CALIFORNIA	74.4	MISSISSIPPI ST UNIVERSITY	28.6
PRINCETON UNIVERSITY	73.6	U OF NEBRASKA-LINCOLN	25.6
UNIVERSITY OF MIAMI	72.1	U OF ARKANSAS MAIN CAMPUS	12.7
U OF PENNSYLVANIA	71.9		

(c) Other Sources of R&D Support - Table 6 summarizes the level and proportion of R&D support that various sources provide to the leading public and private research institutions. These figures further dramatize the extensive role of the federal government in supporting R&D. No other source

provides amounts or shares that approximate federal R&D funds at these institutions.

Table 6

Average Per Institution in R&D Expenditures
and Percentage Share by Source of Funds
1979
(NSF Data)

Leading Public Research Universities	Percentage Share	Millions of Dollars	Leading Private Research Universities	Percentage Share	Millions of Dollars
Federal	61.3%	$25.2	Federal	78.6%	$37.0
Institutional Funds	16.6%	6.8	Other	9.2%	4.3
State & Local Government	13.3%	5.5	Institutional Funds	7.0%	3.3
Other Sources	6.0%	2.5	Industry	3.7%	1.8
Industry	2.7%	1.1	State & Local Government	1.5%	.7
Total R&D (Science and Engineering)		$41.1	Total R&D (Science and Engineering)		$47.1

(d) Changes in Federal Dependency - Within science and engineering R&D, dependency on federal sources showed a marginal decline for the public institutions in the top 100 category, from 61.9 percent to 61.3 percent. For the privates, this share held relatively steady over the period at 78.6 percent. As these percentages indicate, the leading research institutions are highly dependent on federal sources for the support of research. (Source: analysis of NSF data) While aggregate statistics on the extent of dependence on federal sources for R&D support show almost no change, on an individual institutional basis there is significantly greater variability. Forty-five percent of the leading research institutions became less dependent on federal support between 1975 and 1979. Twenty-five percent

followed the average pattern of stability and another 30 percent showed increasing rates of dependency.

(e) Areas of R&D Emphasis - A final topic of interest in a discussion of institutional dependence on federal funds for R&D is how such dependency varies by discipline area. In 1979, at both public and private institutions, reliance on federal sources was greatest in physical science fields (nearly 80-90 percent of funds) and least great in social science fields (45-65 percent of funds). In all cases, however, reliance on federal sources was substantial. Table 7 summarizes these relative federal shares by discipline.

Table 7

Reliance on Federal R&D Funding by Discipline
1979
NSF Data

Leading Public Research Institutions	Federal R&D Dependency Ratios	Leading Private Research Institutions	Federal R&D Dependency Ratios
Physical Sciences	70.6%	Physical Sciences	85.3%
Mathematical and Computer Sciences	57.1%	Mathematical and Computer Sciences	85.0%
Life Sciences	55.0%	Life Sciences	76.4%
Psychology	53.4%	Psychology	75.0%
Environmental Sciences	50.5%	Environmental Sciences	70.5%
Engineering	46.5%	Engineering	64.3%
Social Sciences	43.9%	Social Sciences	64.1%

Although these disciplines all show substantial reliance on federal funds, the levels of R&D expenditures represented by these shares varies considerably. R&D expenditures by discipline clearly emphasize the central role of the life sciences. Leading public research institutions on average conduct $22.6 million in research in life sciences; leading private research

universities spend $26.6 million on average in these fields. Table 8 shows the relative average levels of R&D expenditures in these fields.

Table 8

Average Expenditures Per Institution
for R&D by Discipline
1979
(NSF Data)

Leading Public Research Universities		Leading Private Research Universities	
Life Sciences	$22.6 million	Life Sciences	$26.6 million
Engineering	4.5 million	Engineering	6.9 million
Environmental Sciences	4.4 million	Physical Sciences	6.1 million
Physical Sciences	4.2 million	Environmental Sciences	2.3 million
Social Sciences	2.4 million	Social Sciences	2.1 million
Mathematical & Computer Sciences	.9 million	Mathematical & Computer Sciences	1.5 million
Psychology	.6 million	Psychology	.8 million
Total	39.6 million	Total	46.3 million

An analysis of the overall rates of change in constant dollar R&D expenditures by discipline indicate very different rates of change. Engineering R&D increased in constant dollar terms by 39 percent, followed by physical sciences at 24 percent, environmental sciences at 19 percent, life sciences at 11 percent, and mathematical and computer sciences at 9 percent. Psychology dropped by 4 percent and social sciences experienced the largest real decrease, 12 percent.

Concentration of Federal R&D Funding

A major issue related to the financing of the leading research institutions is the extent to which federal R&D funds shift over time between higher education and other major research providers (i.e., industry, FFRDC's, other nonprofits, and the federal

government itself); and within the higher education universe among different types of institutions (i.e., leading 100, other graduate, land grant, campuses within medical schools, etc.). At issue is a determination of whether higher education's share of the federal pie for R&D is changing and how.

(a) Shares Among Major Research Providers - According to NSF analysis, since 1960, universities and colleges received an increasing share of federal R&D funds. This share increased from 4.6 percent of the total federal pie in 1960 to 13.5 percent in 1979. Within the shorter period of this study (1975 to 1979), this share increased from 12.6 percent to 13.5 percent. It should be noted that given increases in federal R&D spending in this period, colleges and universities received an increasing share of a larger pie. Federal funding of R&D increased from $18.152 billion in 1975 to $26.762 billion in 1979. This increase represents a 47.4 percent current dollar gain, and a 12.5 percent constant dollar gain in federal R&D funding. These increases in share of federal R&D funds going to colleges and universities came at the expense of industry funding. As shown in table 9, all research providers, except industry, have increased their share of the federal R&D pie since 1960.

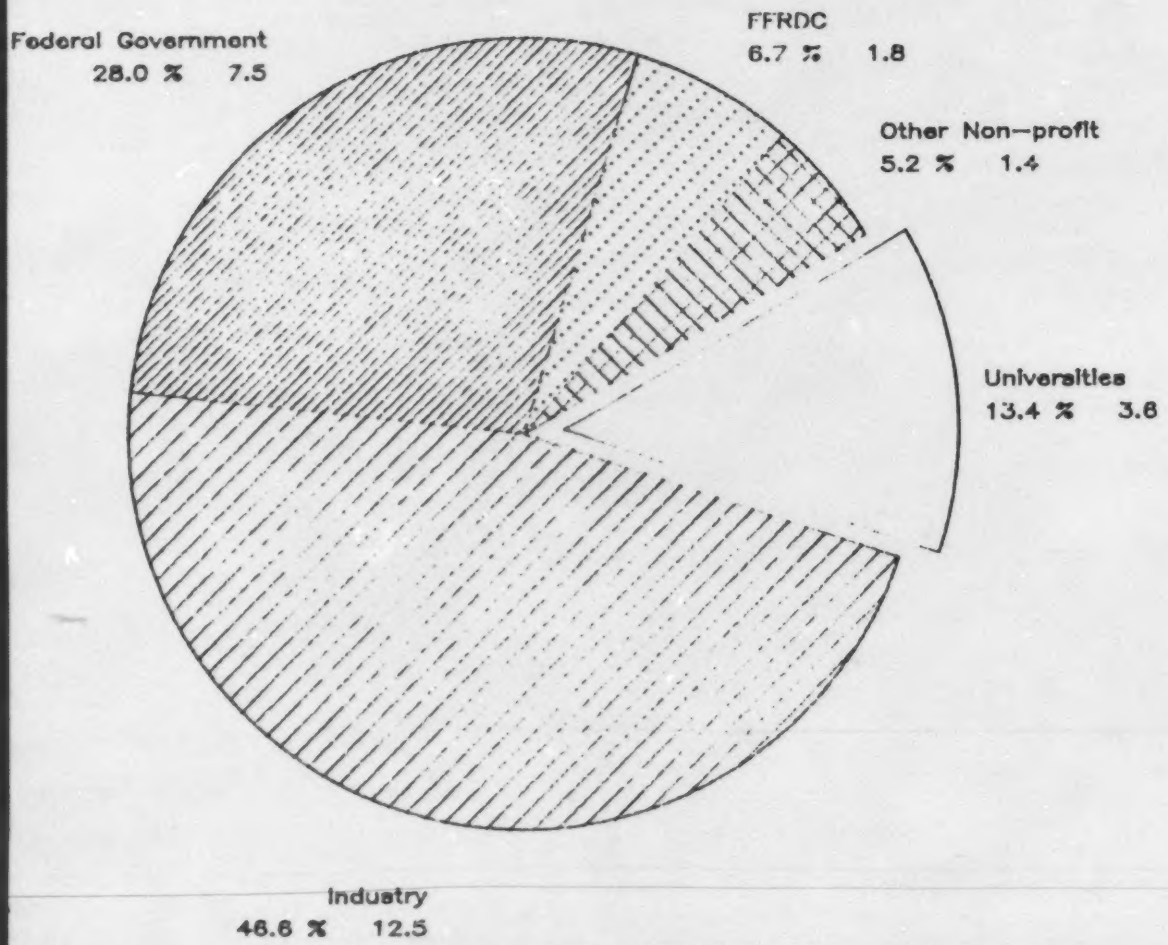
Table 9

Distribution of Federal R&D Funds
1960 to 1979
(NSF Data)

	1960	1979
Industry	69.6%	46.6%
Federal Government	19.8	28.0
Universities & Colleges	4.6	13.5
Associated FFRDC's	4.6	6.9
Other Nonprofits	1.9	5.1

Figure 3

Federal Funding of R&D by Sector
1979



These shares are shown graphically in the following figure, figure 3.

(b) Shares Among Higher Education Providers - The leading research universities received approximately 85 percent of federal R&D funds awarded to graduate colleges and universities (based on NSF data). In terms of total federal grants and contracts, not just research funds, the leading research institutions received more than 60 percent (60.9 percent) of all federal grants and contracts awarded to colleges and universities in the U.S. Between 1975 and 1979 the share within higher education received by the leading research universities remained relatively unchanged. While the proportion of funds did not shift noticably, the level of funding for higher education did increase. Federal R&D funding for universities and colleges increased from $2.288 billion in 1975 to $3.6 billion in 1979. This increase represents a 57.3 percent current dollar gain, and a 13.5 percent constant dollar gain. The proportion of federal funding going to each of the groups examined in this study remained relatively constant between 1975 and 1979. These groups include:

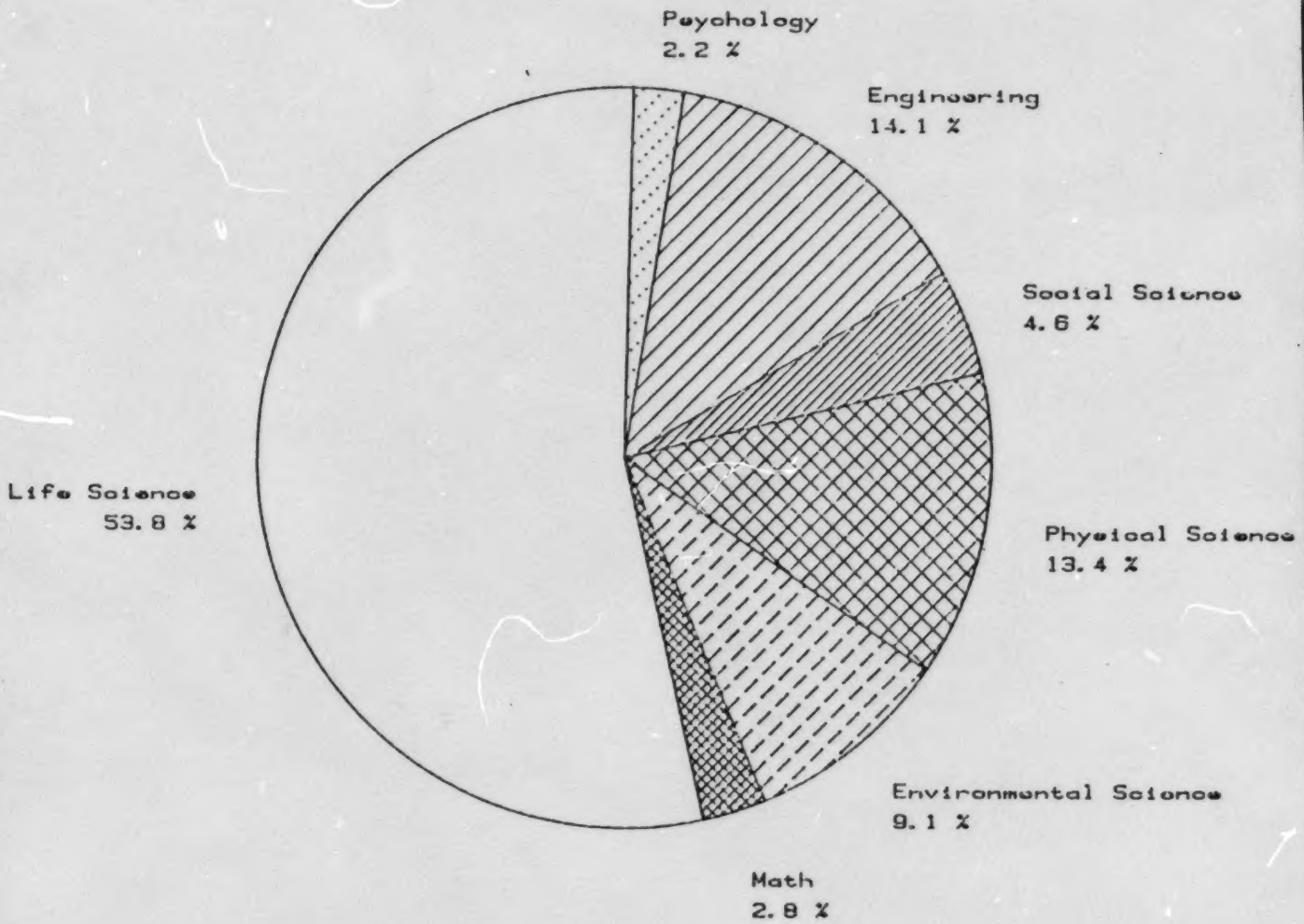
- Top 100, other graduate, and all other institutions
- Public and private institutions
- Landgrant and non-landgrant institutions
- Integrated medical, medical only, and all other institutions

The share of federal R&D funds awarded among different science and engineering disciplines appears relatively constant across all study years, and, within each of the study groups. Between 1975 and 1979, NSF data indicate small positive gains, approximately 1 to 2 percent in engineering, physical science, and environmental science. Losses in percentage shares occurred in the life sciences, psychology, and social sciences. These small

changes in percentage shares, however, translate into significantly different growth patterns across disciplines. The physical sciences, environmental sciences, and engineering all showed constant dollar growth of more than 20 percent. The areas of psychology and social science showed constant dollar losses in excess of 10 percent. The major differences in the share of federal R&D by discipline are clearly evident in figure 4. Life sciences represent the largest share of federal R&D expenditures by a significant portion.

Figure 4

PERCENTAGE SHARE OF FEDERAL R&D EXPENDITURES



(Source= NSF 1979)

Characteristics of Research Universities

Although the distinctive nature of research universities is widely acknowledged in higher education, the specific dimensions associated with that role are not always so clearly understood. This section explores the particular character of research universities by comparing such institutions with "other graduate" higher education institutions in terms of research activities, graduate focus, emphasis on doctoral studies, science orientation of the curriculum, emphasis on particular disciplines, size, and levels of resources. Although there are many other important dimensions associated with the role of a research university not treated here, this analysis forms at least an initial step in empirically clarifying selected relevant dimensions of these universities. In addition, relationships between these characteristics of research universities and institutional dependence and funding levels are examined. It should also be noted that the differences associated with research universities would be even more marked if they were compared to all other institutions, beyond the "other graduate" category that is the focus of this section. Yet even with this restricted group, important differences are clearly evident. A comparison of the leading research universities with other graduate institutions indicates the following set of differences:

- Extent of Research Activity - There are two different data sources for research expenditures--NCES and NSF. NCES figures indicate that in 1979 the leading research universities on average conduct twenty times more sponsored research than other graduate institutions, $36.714 million per leading research institution versus $1.792 million for the "other graduate" institutions. (They do more than 1000 times the level conducted by "all other" institutions.) NSF data for R&D in science and engineering shows a lesser though still substantial difference of eleven times, $43.539 million

for the leading research universities versus $3.986 million for the "other graduate". The leading private universities showed even greater differences in comparison to private "other graduate" institutions of 31 times greater using all research (NCES data) and 18 times greater in science and engineering fields (NSF data). For the publics, the corresponding differences were 16 times (NCES) and 8 times (NSF) respectively.

- o Graduate Focus - The leading public research universities enroll five times more graduate students in their instructional program than public "other graduate" institutions and for similar private institutions the ratio is six times. However, part of these differences are purely related to size. A comparison of the proportions of enrollments that are graduate (including first professional) indicate that almost 20 percent of students in leading public research universities are studying at the graduate level in comparison to 10 percent for the "other graduate" institutions. For the leading private universities, 40 percent of the students are graduate in comparison to almost 19 percent of those enrolled at private "other graduate" institutions. As these figures indicate, control appears to be as important as research mission in the extent of graduate education that is provided.

- o Doctoral Emphasis - Doctoral education is one apparent preserve of the leading research institutions. As a group, they grant 12 times as many doctoral degrees as do the "other graduate" institutions. Using a five-year average per institution, leading research institutions, both public and private, grant approximately 230 doctoral degrees per year. For the "other graduates", the extent of doctoral education is far lower and averages about 19 doctoral degrees per year.

- Science Emphasis in the Curriculum[11] - The relative emphasis on science between leading research and other graduate institutions is not as clearly differentiated as the doctoral orientation of these institutions. The most apparent differences were at the undergraduate level (i.e., Bachelor's degrees) where the research universities were somewhat higher in their emphasis on science (53 percent versus 43 percent). By contrast, at the doctoral level of study, science emphasis was nearly equivalent (about 65 percent). In general then, science orientation in curriculum is not an important characteristic differentiating these institutions.

- Emphasis on Science Disciplines in Research - The leading research universities, as has already been indicated, do many times more research than "other graduate" institutions. In addition, these differences are most marked in specific fields, namely environmental sciences (13 times as much), life sciences (13 times), and physical sciences (10 times the level). The differences are less marked for research in psychology (6 times), mathematical and computer sciences (7 times), social sciences (8 times), and engineering (8 times).

- Size - The leading research universities in general are more than two and a half times larger than other graduate institutions. However, institutional control is at least as important. Leading public research universities on average enroll almost 19,000 students. Similar private universities number close to 10,000 students. The "other graduate" institutions, by contrast, enroll far fewer students, with approximately 7400 per institution in the public sector and 3600 in the private sector.

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[11] Degrees granted by student program is used as a surrogate for the science/nonscience orientation of the instructional curriculum.

- o Level of Resources - Although on average the leading research universities operate with more than five times the level of funds that the "other graduate" institutions receive and more than 30 times the level of "all other" institutions, these comparisons are strongly affected by the differences in size among these institutional types. Once revenues are adjusted for variations in enrollment levels, these differences in revenues are lessened. Still the leading public research universities operate with funds that are 50 percent greater per student than their counterparts in the "other graduate" class ($10,183 versus $6,917 per FTE student in E&G revenues). For the privates, the differences are even more substantial, with leading private research universities receiving revenues that are 170 percent of those received by private "other graduate" institutions ($15,975 versus $5,971 per FTE student). These larger revenue pools support larger amounts of research and many more graduate enrollments. Thus, although the leading research universities appear to be better financed than their counterparts in the "other graduate" institutional group, given their differences in mission and activities, this is not necessarily the case.

These differences in revenue levels are primarily due to differences in funding from government grants and contracts (particularly those that are federal in origin) and from greater state and local appropriations (in the case of public universities) and tuition revenues (in the case of private universities).

Relationship Between Research Funding and Institutional Characteristics

As has just been suggested, differences in revenues for the research universities in comparison to other institutions is primarily due to the differential infusion of federal funds for R&D. Correlational analysis further supports this finding, indicating that high levels of federal funding for grants and contracts are related to

high levels of total funds (r=.88). Levels of federal funding, however, did not necessarily signal or imply a corresponding high level of dependency on federal funds (r=.69). Instead, federal funding was often accompanied by significant R&D funding from other sources (r=.70). Ironically the institutions receiving high levels of federal R&D funds are not necessarily more dependent on those funds, but instead appear to be similarly successful in attracting funds from other sources. This finding is particularly important in light of one of the original hypotheses of this study, that the leading research institutions were highly dependent on federal funding for support. Although it is clear that these institutions do in fact receive large amounts or federal funds, they also are supported by other sources as well. In fact, success in federal funding is often accompanied by success in obtaining funds from other sources.

Other important relationships were examined as well. The results of these analyses indicated that:

- There is a moderate association between R&D funding and the employment of full-time faculty (r=.65 for total R&D expenditures and .53 for federally funded R&D expenditures).

- There is a strong relationship between R&D activity and the number of Ph.D.'s granted (r=.89 for total R&D expenditures and r=.84 for federally funded R&D expenditures). This finding further reinforces the premise of this study that creation of new knowledge and advanced levels of instruction are interdependent activities, at least in the U.S. system of higher education.

- Contradicting one of the original hypotheses of this study, there is a very weak association between the science emphasis of the instructional curriculum and research activity and funding. Instead, the relative mix of science in

the curriculum of research and graduate institutions is fairly similar and operates independently of the research mission of these institutions (the r values were in the .06 to .35 range).

- There is a very strong relationship between research expenditures in a discipline and federal R&D funding for that discipline, mirroring the generally strong relationship between total R&D expenditures and federal R&D support (r=.97). In addition, R&D activity in a discipline tends to be accompanied by graduate study in these disciplines, particularly doctoral study in engineering (r=.88), physical sciences (r=.86), and life sciences (r=.81). For math and psychology, these relationships between R&D activity and doctoral study are weaker (r=.44 and .59, respectively). For social science fields the relationship is more moderate (r=.75).

Implications of This Study

(a) Substantive Implications - The analyses in this study clearly indicated that the leading research universities receive significant shares of their funds from federal grants and contracts (mostly for research). Although it was apparent that these institutions rely to a substantial degree on the federal government in dollar terms, the exact nature of the dependency was not evident in behavioral terms. That is, without additional information about specific institutional policies that are tied to these federal funds (e.g., in supporting tenured versus contract staff, core versus ancillary services, etc.), it is not possible to assess the true nature of dependency. In addition, our finding that high rates of federal contract support for research appear to be accompanied by substantial amounts of funding from other, non-federal sources, further tempers the implications of dependency on federal funds.

Nonetheless, the high degrees of reliance on such federal funds, particularly for research, suggest (1) the importance of efforts to regularly monitor the relationship between federal and total funding with regard to the impact of changes in both federal and non-federal funding on research activities at these institutions; and (2) the need for additional, more detailed inquiry at the institutional level into the specific operational uses of federal R&D funding in order to assess true dependency.

The study showed that since 1960, federal R&D funds had increasingly been directed toward academically based researchers, at the expense of industry-based research. The implications of this shift for the future are not clear, however. Whether higher education will be able to maintain (or increase) their current 13.5 percent portion is not self-evident. In particular, in light of articulated R&D priorities for the 1980's for defense, the space shuttle and selected energy[12] areas, it may be that the long term trend toward higher education providers may stabilize or weaken.

No major shifts in the distribution of federal grants and contracts and R&D funds were evident within higher education, between 1975 and 1979. Whether Smith and Karlesky's prediction of weakening in research at the "other graduate" institutions will occur was not apparent either way in this study. Given that the period under review was characterized by strengthening economic conditions in general and in higher education in particular, such losses would not have been anticipated. The post-1979 period with its forecasted economic difficulties may be another story, however.

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[12] National Patterns for Science and Technology Resources 1980, National Science Foundation, Washington, D.C.: Government Printing Office, 1980, p. 4.

Finally, examination of the distinctive characteristics of the leading research universities provided a clear reaffirmation of the important linkage between research and graduate education, particularly at the doctoral level. This association was most evident in the doctoral fields of engineering, physical sciences and life sciences. (Data on the humanities were not available.) This suggests that institutions concerned with their ability to provide ongoing research should be similarly concerned with nurturing doctoral instruction. Interestingly, an instructional emphasis on science disciplines per se was not strongly associated with high levels of research activity, as had originally been hypothesized.

(b) Technical Implications - Beyond the substantive findings suggested above, the study provided some important insight on technical matters. The following listing summarizes these findings:

(1) Analytical

- The study represents an initial step in establishing a methodology for assessing institutional dependency and related characteristics and conditions. This type of analysis should be periodically updated.

- The importance of examining individual institutional patterns of financing and related conditions was clearly apparent, given the variety (dispersion) of institutional profiles that was evident.

- The results of the analysis suggested that institutional type, control, and the operation of a medical program were important dimensions along which to differentiate such analysis. Landgrant status did not appear to be similarly important.

(2) Data Related

- o There were important limitations in the types of information available for this study. Most visibly absent were detailed data on specific institutional uses of federal funds that would facilitate an in-depth assessment of dependency. A subsesquent research effort is recommended, focused on the assumption that dependency may be more related to the specific use of federal funds within an institution than to the level of such funding.

- o The study would be measurably improved by the availability of a longer time series, than the 1975-79 time period examined. Given the types of data that are available, improved analysis can only occur with the lapse of additional time.

- o The study demonstrated that two different data sets, from NSF and NCES, could be used in parallel, to analyze questions broader than either data set.

- o However such tandem use of these data sets was problematic and required some modifications to each data set. More effective use of these data sets would be facilitated by the following changes:

  - Clarification by NCES through a source/use format within federal grants and contracts revenues in particular (but other grants and contracts categories as well) of which funds are for R&D purposes versus other uses, such as training grants, etc.

  - Clarification within both the NCES and NSF forms of the level of indirect cost reimbursement that institutions receive. This would

improve the matching of these two data files. More importantly, however, such data would provide a much needed base of information for analysis of a subject about which institutions, as indicated by the project's Evaluation Panel, are very concerned.

- Adoption by NSF of the campus as the reporting unit, for institutions that are organized within a multi-campus system. NCES uses such a reporting procedure. Such a clarification of procedure would represent a specific guideline to institutions, would remove any appearance of positioning game playing, and would improve the cross agency utility of NSF's data.

- Addition of research in non-science fields to NSF's data collection, to ensure that all sponsored research is measured. Compatibility with NCES collections would also be improved by this step.

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